

# **Appendix I. Architecture Concepts and Alternatives**

## **BACKGROUND**

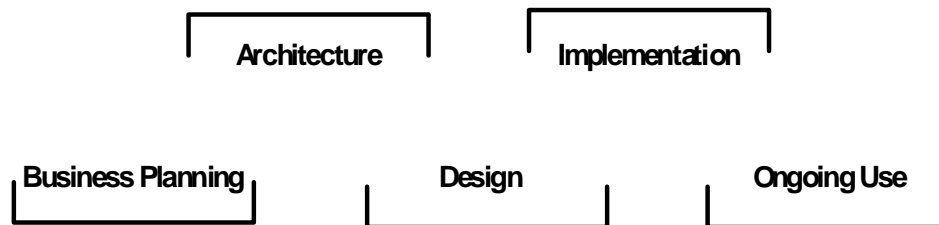
Dramatic changes in technology and economics are enabling the rapid deployment of computing and communications infrastructure across much of the world. The government and its trading partners stand to benefit substantially from the capability to process information faster and more accurately. Increasingly, the government is beginning a new way of doing business within the United States and abroad. To fulfill the economic commerce initiative, the government must keep up with the information explosion that is occurring throughout the world and be an active proponent of it.

## **DEFINITION**

The technical architecture is the overarching technical plan — a blueprint or roadmap — by which to achieve the desired objectives of an information system. At the heart of an architecture is the definition of the system. A system is a functionally complete solution to meeting a need. That definition, however, can be nested; that is, one person's system can be another person's component. For example, a personal computer sitting on a desktop may be described as a complete system with its own architecture. On the other hand, that same personal computer may be one of several thousand components of an enterprise network, which also has a distinct architecture. An architecture provides a conceptual framework for relating components, broadly based solutions, and formal descriptions of the components. Furthermore, the goal is to provide a concise statement, without going into specific details, of an EDI technical architecture that can be understood and implemented. This architecture translates the programmatic requirements from the disciplines of procurement and finance into terms understandable by technical specialists in telecommunications, data base, security, and data interchange. It assumes an understanding of these technical disciplines.

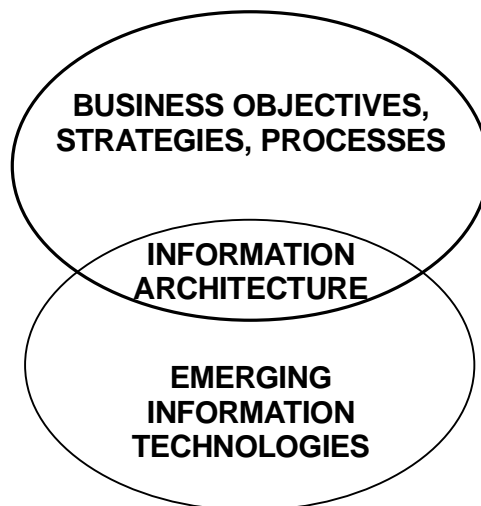
For purposes of this report, a technical architecture is a set of specifications that define the interrelationships among the parts of a system. The first step in an architectural process is to define the boundaries and functions of a system and identify its various components or elements. The next step is to define the distribution of functions among the elements for that is where many of the cost and performance characteristics of the system are determined. Interfaces between system elements are defined by this distribution of functions, and those interface specifications are the heart of the architecture and the linkage between conceptual functionality and implementation activities.

A key purpose of the architecture process is to support modular and incremental development, allowing different developers at different times and in different locations to develop distinct elements of a complex system that fit together as desired. That process enables independent testing and makes system capabilities available throughout the development cycle and thus reduces risks inherent in complex enterprise-wide systems. Figure I-1 depicts the positioning of the architecture activity and how it is linked to information technology (IT) development activities within the system development cycle.



**Figure I-1. Architecture Linkage with IT Development Activities**

A key principle of architectural definition is alignment with the business objectives of the organization. An information architecture should be directly linked with the mission, strategies, and critical success factors of the enterprise and business processes should be engineered to maximize the utility of the technology. Architecture provides the structure by which to introduce innovative information technologies in a manner consistent with business goals. Figure I-2 depicts this relationship.



**Figure I-2. Architecture Linkage with Business Objectives**

Historically within the information industry, architecture has been mostly the task of vendors. When users chose a vendor, they also implicitly chose an architecture. Each vendor had its own architecture and the various architectures were largely incompatible. Within the past decade, that approach has changed with the definition and wide scale implementation of standards. Some standards have been developed by officially chartered standards committees while others have been developed through privately defined technology that has been made widely available. In any case, the user can now choose products from multiple capable vendors and is able to benefit from increased competition and industry-wide economies of scale. However, the user is now the "point of integration" for the information system and, as a result, the responsibility for architectural integrity and the interworking of system elements is shifting to the user.

## ENTERPRISE-WIDE SYSTEMS ARCHITECTURE

When establishing an enterprise-wide systems architecture, organizations need to define an overall IT strategy. That strategy must consist of several components that are aligned with achieving organizational missions most effectively and efficiently. The objective of this architecture is to work in partnership within other government organizations and with the private sector to provide a transparent architecture that allows technological improvement without undue disruption to the end user. The result will be that all members of any government organization have timely and easy access to the right information presented in an effective form so that they can do their jobs in the best possible manner. In addition, the government will be able to manage information resources to ensure the reliability and availability of the total system, that provides the delivery mechanisms for the information. Figure I-3 depicts these elements of the IT strategy.

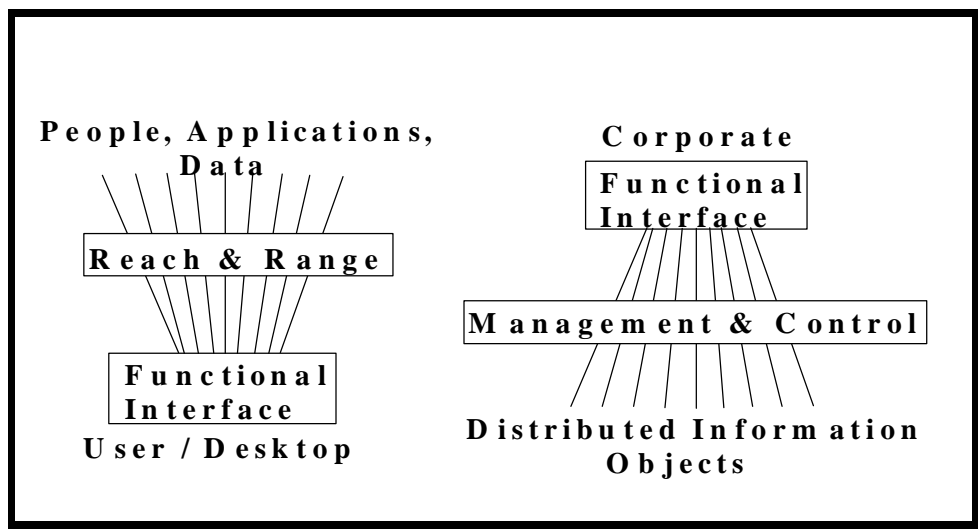


Figure I-3. Elements of the IT Strategy

Figure I-3 depicts the overall functionality that the architecture provides, where any user having functional interface to agency systems can reach all users, applications, and data if access has been granted. The corporate systems, on the other hand, having functional interface with external systems, provide management and control over distributed information objects internal to their systems as well as those which reside externally.

The major architectural difference between all models examined is the degree to which the model is centralized. A major drawback of the centralized approach in a multiagency situation is the problem of assignment of responsibility and the confusion of mission that could arise. The advantage of this approach is its simplicity. Decentralized architectures require coordination between components and are more complex to implement and maintain, but they do not suffer from the existence of a single point of failure.

The objectives of the target architecture and the concepts of the virtual network that are the key to implementing this architecture for the Federal government are described elsewhere. Only the alternatives are discussed here, and they fall into two general categories: centralized and decentralized.

The components described in Appendix K may be either required or optional, but the services provided by the sum of the components are required to ensure that end-to-end transfer of data is consistent with the “single face to industry” philosophy. For some alternatives there is a clear stipulation that use of a component is strictly optional, and for some options, components are required. Use of a centralized architecture provides a convenient point for enforcement for that single face. With decentralized models, enforcement must take place at a number of locations. A “single face to industry” encompasses use of common sets of procedures for doing business with the government, use of a common, open set of communications protocols, and standardized EC implementation agreements. All that will be necessary to achieve enforcement in this way is accessibility to information and definition of the rules for adherence. Generally this will mean access to the necessary data bases.

There are a number of variants on each of these alternatives, some of which are discussed below. Evaluation of these alternatives include bandwidth availability, network communication hops, technology linking networks together, and interoperability. Although there are no empirical data available to show specific instances in the Federal government of savings derived from these factors, nevertheless, agencies can evaluate these factors as they relate to internal resource availability for interworking. These factors are a function of not only the degree of decentralization of components, but also the degree of sharing required common services with other agencies. These considerations should include, but are not limited to, the following:

- System/network management

- Economics (i.e., economies of scale)
- Service availability and reliability
- Flexibility in meeting future requirements
- Transition toward target architecture
- Available technologies.

## DOD PROCESS ACTION TEAM ARCHITECTURE

The DoD Process Action Team (PAT) offers an example of an architecture for EC for the Department of Defense (DoD). The PAT studied the internal DoD structure and plan for utilizing EC for procurement activities throughout the Department. Figure I-4 depicts that architecture as described in the DoD PAT report dated 20 December 1993. The DoD model can be described as the bi-directional flow of data from the trading partner through a VAN, a distribution point (DP), a gateway, and finally to the government application. The Defense Information Systems Agency (DISA) will implement the architecture and provide the connectivity to the various DPs, gateways, component systems, and the trading partners via the Defense Information System Network (DISN) and the Defense Message System (DMS).

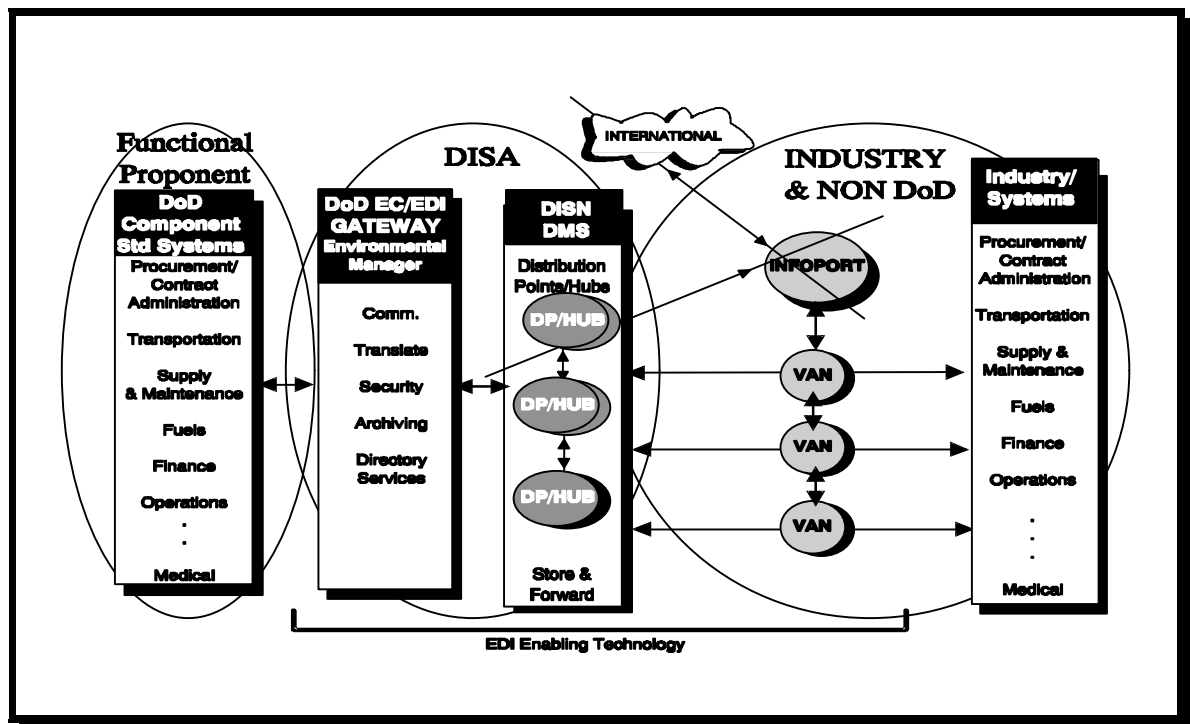


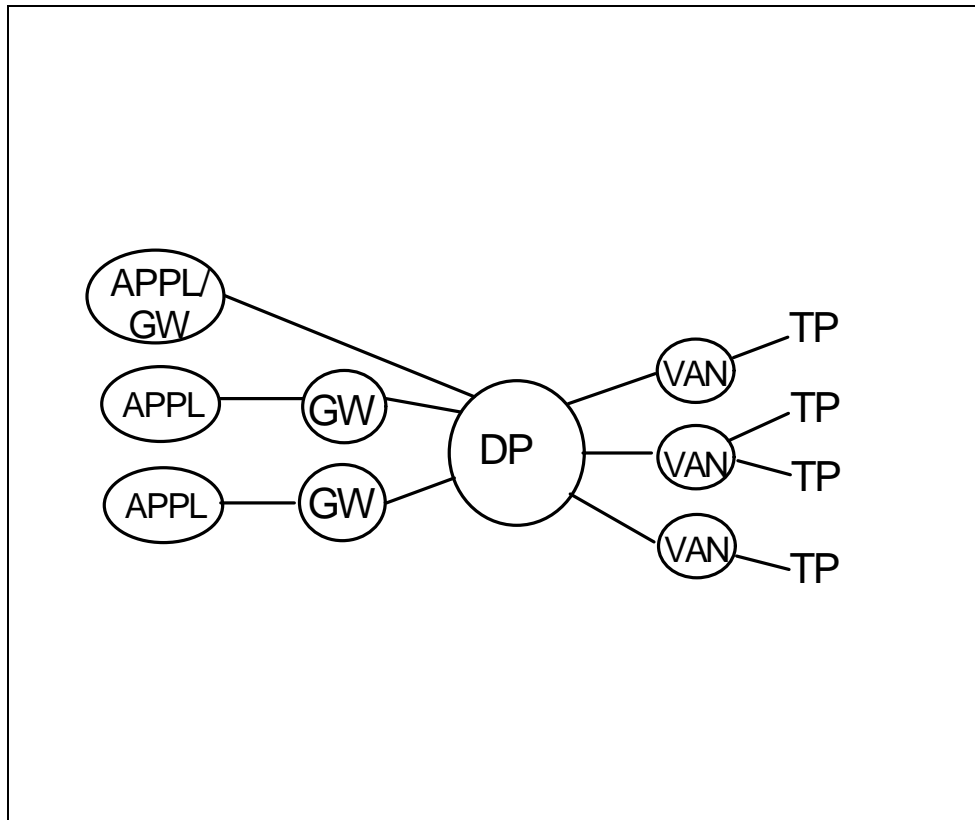
Figure I-4. DoD Internal Infrastructure for EC

The DoD model has essentially two levels of distribution capability. The distribution point provides direct connectivity to the gateways. The DPs concentrate traffic and provide connectivity to all VANs and maintain a communications path to all other communications DPs and agencies. The DP concept provides a limited number of connection points from which data needed by all VANs must travel to be distributed to any or all VANs. The DoD configuration currently has two DPs which provide backup for each other. The DoD architecture provides a viable operating environment, as shown by several prototypes that have been operating at DoD locations for some time.

## **CENTRALIZED ARCHITECTURES**

The principal advantage to a more centralized network architecture is that it allows for simplified system and network management when compared to decentralized architectures. As technology evolves, however, system and network management is becoming more capable of closely monitoring decentralized components of an architecture. Therefore, the advantages to centralized network architectures will become more associated with the availability of resources (staff, facilities, and money) than with the capabilities of technology. A significant aspect of a centralized architecture is that there is more likely to be a single point of failure capable of disabling the entire system. The possibility exists also, that there will be greater system and network slowdowns because of overload due to the significant amount of communications traffic that must go through a centralized facility.

In the scenario shown in Figure I-5, all gateways are connected to a single distribution point that connects to all the VANs. This is the most centralized of all scenarios and requires the greatest connectivity challenge. In this case, the “single face” for connectivity protocols begins at the distribution point, which receive transactions from gateways via dissimilar communications protocols such as simple mail transfer protocol (SMTP) or file transfer protocol (FTP). The distribution point routes them to the VANs in a standard communications envelope. Without the distribution point, support for many different protocols would have to be provided by the VANs.



**Figure I-5. Single Distribution Point**

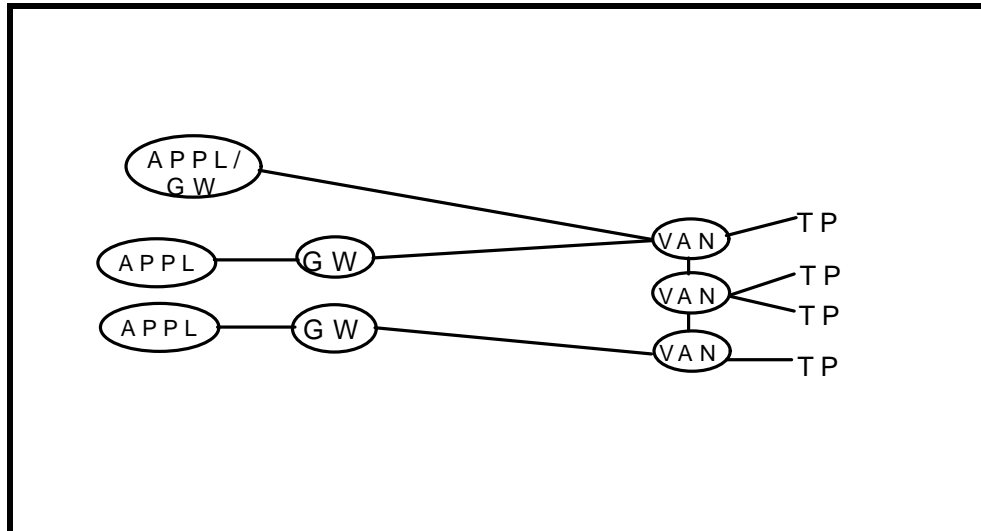
## **DECENTRALIZED ARCHITECTURES**

Decentralized architectures do not suffer from the same single-point-of-failure issues as centralized architectures. However, they are more complex to implement and manage because of the need for coordination between the many disparate components of the system. There are many communication paths in a decentralized network, facilitating reliability and the sustainability as well as a greater capability to expand and meet additional connectivity requirements. Because network technology is advancing rapidly, the architecture decisions become very specific to available agency resources, the services required to meet requirements, and the ability of the agencies to share those services. In the scenarios presented below, without a network, there are questions relating to interagency communication of standard EC and other information. Each agency must have connection to every other agency that it needs to pass data to. In addition, VANs must have connections to each agency with which its trading partners wish to do business.

### **NO NETWORK WITH INTERCONNECTED VANs**

Figure I-6 shows this architecture, which is the most decentralized of the architectures. With this option, each agency functional area that maintains an application (procurement, finance, personnel, etc.) must obtain its own EDI VAN

services, thus establishing connectivity with trading partners using the long-haul data communications networks provided by the VANs. This option typically involves independent procurements for each agency. The resulting proprietary solutions would not likely lead to the required “single face to industry.”



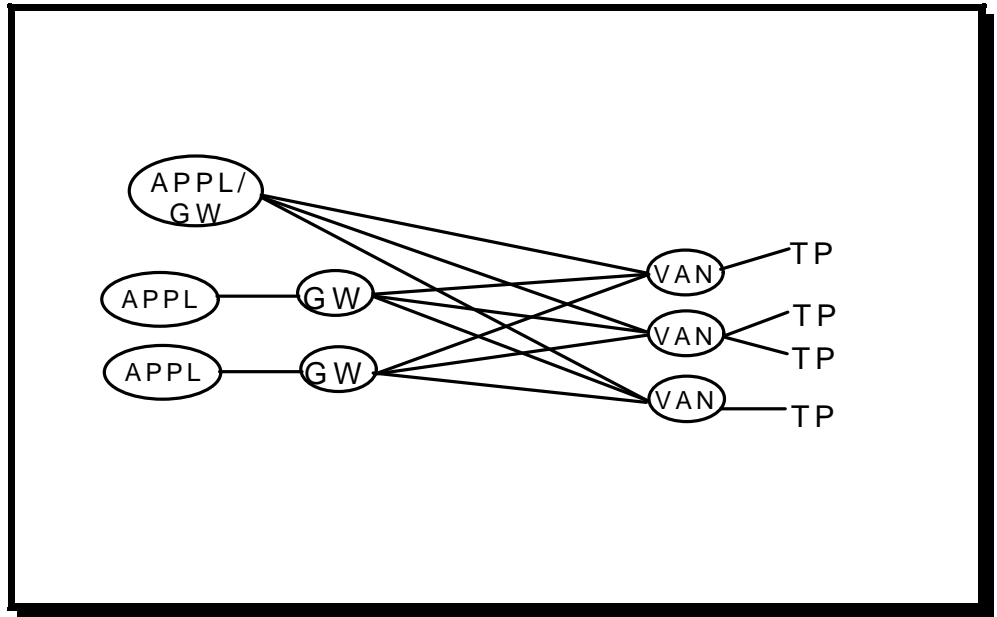
**Figure I-6. No Network with Interconnected VANs**

In this scenario, each gateway has access to at least one VAN. Sending to all trading partners is achieved by requiring that all VANs are interconnected. Thus, a VAN receives a transaction to be sent and conveys the transaction to other VANs, as well as to the trading partners it services directly. The cost of this service is likely to be levied upon the trading partners desiring access to the information. In this scenario, transactions directed to specific trading partners require that each VAN have knowledge of the specific VAN servicing a specific trading partner. Another possible scenario is that these transactions are sent to all VANs similar to broadcasting messages; the VAN servicing that specific trading partner is the only one that actually delivers it to its intended destination.

#### **NO NETWORK WITHOUT INTERCONNECTED VANs**

In this scenario, rather than requiring the VANs to interconnect, each gateway interconnects to all VANs. Clearly, this places increased requirements on the gateway, assuming the network functionality by all the gateways will likely result in increased cost. These increased costs need to be evaluated against the benefits and costs of maintaining a network. This disorganized picture is generally true today and is the primary reason that we propose a government-wide set of interconnected networks. The divergence of protocols, security, infrastructure, and processes for procurement presents many “faces” to industry, as shown in Figure I-7.





**Figure I-7. No Network and No VAN Interconnection**

## SUMMARY

The same communications services, for example, E-mail and file transfer, can be provided with any of the architectural models presented above. There may be some minor differences imposed on users that are required to send messages through the NEP. Otherwise, there do not appear to be significant benefits or drawbacks with regard to communications services provided, regardless of the model employed.

In view of the need for all agencies (DoD and civilian) to participate jointly in the EC initiative, the objective of presenting a "single face to industry," and the requirement that certain of the supporting data bases be administered according to specific agency mission (e.g., GSA List of Parties Excluded from Procurement and Nonprocurement Program), a mixed architecture seems most appropriate.